First Hit Previous Doc Next Doc Go to Doc#

End of Result Set

Generate Collection | Print

L2: Entry 1 of 1 File: DWPI Jun 19, 1984

DERWENT-ACC-NO: 1984-177280
DERWENT-WEEK: 198429

TITLE: Radial car tyres used at high inflation pressures - having improved rolling resistance without loss of other characteristics

INVENTOR: FURUYA, S; TOGASHI, M

PATENT-ASSIGNEE:

ASSIGNEE	CODE
BRIDGESTONE TIRE KK	BRID

PRIORITY-DATA: 1981JP-0115350 (July 24, 1981)

Search Selected | Search ALL | Clear

PATENT-FAMILY:

PUB-NO	PUB-DATE	LANGUAGE	PAGES	MAIN-IPC
CA 1169344 A	June 19, 1984		024	
JP 58016906 A	January 31, 1983		000	

APPLICATION-DATA:

PUB-NO	APPL-DATE	APPL-NO	DESCRIPTOR
CA 1169344A	July 22, 1982	1982CA-0407837	

INT-CL (IPC): B60C 9/08; B60C 11/00

ABSTRACTED-PUB-NO: CA 1169344A
BASIC-ABSTRACT:

Process comprises raising the internal (knflation) pressure to reduce the deformation amt. of the tyre under load. However, the ground contact area is reduced which results in lower frictional force against dry and wet raods, thus giving poorer ride performance and reduction in cornering stability.

The deformation state of the tyre at the ground contact area is different from that an an entering or deparing area next to the ground contact area. By finite element analysis, the inventors have found that the contribution of each portion of the tyre to its rolling resistance is very different between the ground contact area and the entering or deparing areas. For instance, the tread portion contributes 64% of resistance at an inflation pressure of 2.5 kg/sq.cm. in the ground contact area, but only 27% in the entry or departure areas. By adjusting the 25% modulus and the dynamic modulus of the rubber compounds in the various portions of the tyre, in a

similar fashion to that disclosed in CA1169343, the rolling resistance has been improved without deterioration in other characteristics.

ADVANTAGES - Previous attempts to improve rolling resistance have caused reductions in wet performance, rid performance and lower cornering stability as tread composition has been modified. This method considers the contribution made by all the various portions of the tyre, and is applicable even when a tyre has an aspect ratio of not more than 0.7.

CHOSEN-DRAWING: Dwg.0/6

TITLE-TERMS: RADIAL CAR TYRE HIGH INFLATE PRESSURE IMPROVE ROLL RESISTANCE LOSS CHARACTERISTIC

DERWENT-CLASS: A95 Q11

CPI-CODES: A12-T01B;

POLYMER-MULTIPUNCH-CODES-AND-KEY-SERIALS:
Key Serials: 0009 0011 0222 0231 2212 2307 2623 2628 2635 2658 3258 2826 3297

Multipunch Codes: 014 032 04- 303 308 309 311 41& 50& 551 560 562 566 567 573 597 599 609 651 672 723

SECONDARY-ACC-NO:
CPI Secondary Accession Numbers: C1984-074874
Non-CPI Secondary Accession Numbers: N1984-132295

Previous Doc Next Doc Go to Doc#

Consumer and Corporate Affairs Canada Consommation et Corporations Canada

(11) (A) No. 1 169 344

(45) ISSUED 840619

(52) CLASS 152-124

(51) INT. CL.^{3} B60C 11/00

(19) (CA) **CANADIAN PATENT** (12)

(54) PNEUMATIC RADIAL TIRES FOR PASSENGER CARS USED UNDER HIGH INTERNAL PRESSURE

(72) Togashi, Minoru; Furuya, Shinichi, Japan

BEST AVAILABLE COPY

(73) Granted to Bridgestone Tire Company Limited Japan

(21) APPLICATION No. 407,837

(22) FILED 820722

(30) PRIORITY DATE Japan (115,350/81) 810724

No. OF CLAIMS 5

Canada

Abstract of the Disclosure

A pneumatic radial tire for passenger cars used under a high internal pressure of 2.0-3.0 kg/cm² is disclosed, which comprises a body reinforcement including in combination of a carcass composed of at least one rubberized ply containing organic fiber cords arranged in a substantially radial plane of the tire and wound around a bead core from the inside toward the outside thereof and a belt composed of at least two rubberized layers superimposed about a crown portion of the carcass, each of which containing high elasticity cords inclined at a relatively small angle with respect to the circumferential direction of the tire and the cords of these layers being crossed with each other, and further comprising sidewall rubbers disposed at both sides of the carcass and a tread rubber with a two layer structure composed of an under-tread rubber completely covering the outer surface of the belt and a top-tread rubber superimposed thereabout. In this tire, the under-tread rubber has a modulus at 25% elongation of 2.0-8.0 kg/cm² and a dynamic modulus of 8.2-33.0 kg/cm².

This invention relates to pneumatic radial tires for passenger cars, and more particularly to pneumatic radial tires for passenger cars used under a relatively high internal pressure of about 2.0-3.0 kg/cm², which can advantageously realize the improvement of rolling resistance without causing drawbacks such as deterioration of ride feeling against vibration, decrease of restoring torque in the cornering and the like.

At the time clamoring energy-saving, the reduction of rolling resistance in tires is strongly demanded in order to reduce fuel consumption of automobiles. In this connection, it is effective to decrease internal friction loss produced by the deformation of the tire during the running in order to reduce the rolling resistance of the tire.

In order to reduce the rolling resistance by decreasing the internal friction loss of tread rubber, for instance, it is usually performed to decrease loss tangent (tan δ) and loss modulus (G") and raise rebound resilience in the rubber composition for the tread. In this case, however, the wet performance being an important property in this type of the tire is undesirably deteriorated in accordance with the degree of improving the rolling resistance. This relationship is shown in Fig. 1 as a function of rebound resilience of the tread rubber. Therefore, this countermeasure cannot expect the remarkable improvement of the rolling resistance unless there is taken another means for preventing the deterioration of the wet performance. Particularly, there is found no effective means for holding the wet performance, so that the above countermeasure is

not too effective in practice.

As the second countermeasure, it is particularly attempted to apply rubber having substantially the same composition as used in the tread rubber to sidewalls of the tire. In this attempt, however, the rolling resistance is practically improved only by about 3% or less, while the damping characteristic against vibration produced in the tire is deteriorated to adversely affect the significant ride feeling of the tire.

Besides, there are adopted various means for reducing the rolling resistance by weight-saving of tire, for example, by changing the carcass from two ply structure to single ply structure or by making the width of the belt narrow, but these means cause the deterioration of the cornering stability due to the reduction of rigidity in main reinforced portions of the tire. As a result, they are unavoidable to be critical in the effect.

Apart from the rubber composition lessening the internal friction loss and the weight-saving of tire as mentioned above, it is considered to improve the rolling resistance by raising the internal pressure of the tire to reduce the deformation amount of the tire subjected to a given load. In this case, however, the ground contact area of the tire is usually reduced with the reduction of deformation amount, which causes the reduction of frictional force against dry and wet road surface, so that it is difficult to use the rubber composition for tread lessening the internal friction loss. Furthermore, the reduction of deformation amount due to high internal pressurization does not sufficiently develop the effect with the rubber

composition for sidewall lessening the internal friction loss, but also lowers the safety factor when using together with the means for the weight-saving of the tire, so that the latter case is obvious to be hardly practised. Under such circumstances, the rolling resistance is not improved to an expected extent. In addition, the high internal pressurization not only increases an impulsive force when the tire strikes on obstructions protruded from road surface to deteriorate the ride feeling against vibration, but also causes the reduction of the required restoring torque in the cornering of tire producing a certain slip angle to deteriorate the cornering stability, so that it is unsuitable for practical use.

The inventors have made basic investigations with respect to the deformation state of the high internal pressurized tire and found that the improvement of rolling resistance in such a tire is actually realized by taking a measure as mentioned below without causing deterioration of ride feeling against vibration and the decrease of restoring torque. That is, the invention results from such a peculiar research development that the change of contribution ratio to internal friction loss at each portion constituting the high internal pressurized tire is made clear as compared with that of the usual internal pressure tire.

The invention will now be described in detail with reference to the accompanying drawings, wherein:

Fig. 1 is a graph showing a contrary relationship between index of rolling resistance and index of wet performance for rebound resilience of tread rubber as

mentioned above;

Figs. 2a and 2b are graphs showing influences of static and dynamic moduli of under-tread rubber on the rolling resistance, respectively;

Figs. 3a and 3b are graphs showing influences of static and dynamic moduli of carcass coating rubber on the rolling resistance, respectively;

Figs. 4a and 4b are graphs showing influences of static and dynamic moduli of belt coating rubber on the rolling resistance, respectively; and

Figs. 5 and 6 are schematically radial half sections of embodiments of the pneumatic radial tire used under a high internal pressure according to the invention, respectively.

Now, the deformation of the tire in the running concentrates in the ground contact area of the tire and its neighborhood, but the deformation state at the ground contact area just beneath the rotational axis of the tire is different from that at an entering or departing area near the ground contact area. Therefore, the feature of individually grasping these deformation states is particularly important in order to reduce the rolling resistance resulted from the resistances to these deformations. The inventors have aimed at this point and found from analytical results by finite element method that the contribution ratio to internal friction loss in each portion of a tire as shown in the following Table 1 under an internal pressure of 2.5 kg/cm^2, which is within a range of 2.0-3.0 kg/cm^2 aimed at the invention, is largely different from that under a usual internal pressure of

1.7 kg/cm² applied to general tires for passenger cars. Here, the tread portion means a portion extending between mutual tread ends or shoulders, the bead portion means a portion restrained by a flange of a wheel rim, and the sidewall portion means a remaining portion extending from the tread portion to the bead portion.

Table 1 Contribution ratio of each portion of tire to internal friction loss

Internal pressure	Ground contact area just beneath the rotational axis of tire		Entering or departing area near ground contact area	
	1.7 kg/cm²	2.5 kg/cm²	1.7 kg/cm²	2.5 kg/cm²
Tread portion	48%	64%	41%	27%
Sidewall portion	38%	25%	43%	53%
Bead portion	14%	11%	16%	20%

From the data of Table 1, it is understood that the high internal pressurized tire is high in the contribution ratio of the tread portion and low in the contribution ratios of the sidewall and bead portions at the ground contact area just beneath the rotational axis of the tire but high in the contribution ratio of the sidewall portion at the entering or departing area near the ground contact area as compared with the usual internal pressure tire. Therefore, the feature of reducing the internal friction loss in such portions having a high contribution ratio is said to be a technic suitable for improving the rolling resistance of the high internal pressurized tire.

At first, the inventors have made studies with

respect to the internal friction loss of the tread portion located at the ground contact area just beneath the rotational axis of the tire and found that there is a difference in the deformation state between a portion near the tread surface and a portion adjacent to a belt. That is, the deformation of the portion near the tread surface is determined by a force transmitted between the tire and the road surface, while the deformation of the portion adjacent to the belt is controlled by transmitting a deformation of the belt as a shearing strain.

Aiming at the latter deformation and considering that the deformation of the belt is substantially determined by a tension or rigidity of the belt, it is understood that the shearing strain applied to the tread rubber adjacent to the belt is approximately constant irrespective of its properties. On the basis that the shearing strain is constant, the internal friction loss EL due to the shearing strain of the tread rubber adjacent to the belt is expressed by the following equation:

$$EL = \frac{1}{2}G\gamma^2 \times \text{vol} \times \tan\delta \qquad \ldots\ldots\ldots\ldots\ldots \quad (1)$$

, wherein G is a static modulus or dynamic modulus (G'), γ is a value of strain, and tan δ is a loss tangent related to loss modulus or rebound resilience. Therefore, there is obtained a new knowledge that the rolling resistance can be improved by lowering the value of G or G' in view of the properties of the tread rubber without changing the value of tan δ in the equation (1) to reduce the internal friction loss.

This new knowledge can be realized in tires comprising a tread of two layer structure composed of an under-tread rubber for completely covering the belt and a top-tread rubber by selecting the static or dynamic modulus of rubber for the under-tread rubber within a particular range of lower values.

In Figs. 2a and 2b are shown results for the rolling resistance actually measured by changing modulus at 25% elongation (hereinafter referred to as 25% Mod.) and dynamic modulus as properties of the under-tread rubber under a high internal pressurized condition (internal pressure=2.5 kg/cm²), respectively. As apparent from these results, when the under-tread rubber has 25% Mod. of 2.0-8.0 kg/cm² and dynamic modulus of 8.2-33.0 kg/cm², the reduction of the rolling resistance to 93-85 as an index value can advantageously be achieved.

Moreover, the dynamic modulus is a value measured at 50°C, 15 Hz and an amplitude of dynamic shearing strain of 1% by means of a mechanical spectrometer (made by Rheometrix Corp.).

As previously mentioned, when a given load is applied to the tire under a high internal pressure, the ground contact area of the tire reduces with the decrease of the deformation amount of the tire, which is also apparent to cause the increase of ground contact pressure of the tire. As a result, a larger compression strain is applied to the tread rubber as compared with the case under the usual internal pressure, which also acts together with the shearing strain produced by the deformation of the belt to the under-tread rubber.

Accordingly, the feature that 25% Mod. and dynamic modulus of the under-tread rubber are selected within the particular range of lower values means that the compression deformation amount of the tread portion can be increased and hence the impulsive force in the striking of the tire on obstructions protruded from road surface can be reduced to cover the deterioration of ride feeling against vibration due to the high internal pressurization.

Moreover, it is favorable that the unevenness of the deformation at ground contact of radially outward tread rubber portion or top-tread rubber, which is produced by the difference in 25% Mod. and dynamic modulus between the top-tread rubber and the under-tread rubber, is disposed by the under-tread rubber to attain uniform contact of tire with road surface. This is particularly effective when the tire is run at a given slip angle during the cornering, which does not cause substantially the decrease of restoring torque even when the tire is used under high internal pressure.

Next, the inventors have aimed at the deformation state of the sidewall portion giving a large contribution ratio to internal friction loss at the entering and departing areas near the ground contact area of the high internal pressurized tire. In this connection, there are known two deformations, one of which being a bending deformation produced on the outside of the sidewall portion and the other of which being a shearing deformation produced inside the sidewall portion. Particularly, the shearing deformation becomes important because it is small in the ground contact area just beneath the rotational axis of

the tire but occupies 75% of total deformation of the sidewall portion in the entering and departing areas near the ground contact area. Now, the inventors have further aimed at a strain produced by the shearing deformation or a shearing strain and got a significant knowledge as described below.

That is, the distribution of the shearing strain in the thickness direction of the sidewall portion is maximum in the vicinity of the carcass ply cord and the shearing deformation of the sidewall portion is substantially determined by the tension of the carcass ply, so that the shearing strain of rubber arranged in the sidewall portion is approximately constant irrespective of its properties.

On the basis of the above fact, it has been accomplished that the rolling resistance can be improved by lowering the static modulus G or dynamic modulus G' according to the aforementioned equation (1) showing the internal friction loss due to the shearing strain without the change of loss tangent, loss modulus or rebound resilience as carried out in the prior art.

The effectivity of the above knowledge can be developed at maximum by applying to a coating rubber for carcass ply cords or a carcass coating rubber with such a consideration that the shearing strain is maximum in the vicinity of the carcass. Really, a change of the rolling resistance was measured by changing 25% Mod. and dynamic modulus of the carcass coating rubber under a high internal pressurized condition (internal pressure=2.5 kg/cm²) to obtain results as shown in Figs. 3a and 3b. From the data

of Figs. 3a and 3b, it has been confirmed that if the index of rolling resistance is 100 in case that 25% Mod. of the carcass coating rubber is about 9.3 kg/cm² as used in the prior art, the rolling resistance of the high internal pressurized tire can be improved to 93-83 as an index value when the carcass coating rubber has 25% Mod. of 2.0-6.0 kg/cm² and dynamic modulus of 8.2-20.4 kg/cm².

When 25% Mod. and dynamic modulus of the carcass coating rubber are selected within the particular ranges of lower values as described above, the ride feeling against vibration and the cornering stability of the high internal pressurized tire are further improved.

The invention is to advantageously achieve the improvement of the rolling resistance in the pneumatic radial tire used under an internal pressure higher than the usually used value as mentioned above, and is particularly characterized by selecting 25% Mod. and dynamic modulus of the under-tread rubber and further the carcass coating rubber from the particular ranges of lower values.

The above experiments were made under an internal pressure of 2.5 kg/cm². However, when the internal pressure is slightly higher than the above value, or when 25% Mod. of the top-tread rubber is higher than 2.5 times of 25% Mod. of the under-tread rubber and hence the compression strain due to the difference in the properties between the under-tread rubber and the top-tread rubber is apt to concentrate in the under-tread rubber, there may be reduced the improvement of the rolling resistance to a certain extent. In this case, the loss modulus and loss tangent of the under-tread rubber can be made smaller than those of the

top-tread rubber so as to meet the object.

According to the invention, there is used a belt composed of at least two layers each containing high elasticity cords therein and also 25% Mod. and dynamic modulus of the under-tread rubber and carcass coating rubber are lowered, so that there may be caused a fear of producing separation failure resulted from discontinuity of rigidity under severe conditions. Such a failure can easily be solved by selecting 25% Mod. and dynamic modulus of a coating rubber for cords of the belt or a belt coating rubber from particular ranges of lower values to make the difference of the rigidity small.

In this connection, when the under-tread rubber has 25% Mod. of 6.5 kg/cm² and dynamic modulus of 26.0 kg/cm² and the carcass coating rubber has 25% Mod. of 6.0 kg/cm² and dynamic modulus of 20.4 kg/cm², the durability to separation failure is measured with respect to tires A and B, wherein the tire A comprises a belt coating rubber having the same 25% Mod. of 15.0 kg/cm² and dynamic modulus of 59 kg/cm² as in the prior art and the tire B comprises a belt coating rubber having 25% Mod. of 8.0 kg/cm² and dynamic modulus of 32.9 kg/cm², to obtain a result as shown in the following Table 2, which is expressed by an index on the basis that a tire having the same values of 25% Mod. and dynamic modulus of the under-tread rubber, carcass coating rubber and belt coating rubber as in the prior art is 100. The larger the index value, the better the durability.

Table 2

Tire	Under-tread rubber 25% Mod.	Carcass coating rubber 25% Mod.	Belt coating rubber 25% Mod.	Durability
A	6.5	6.0	15.0	80
B	6.5	6.0	8.0	105

As apparent from the data of Table 2, when 25% Mod. and dynamic modulus of the under-tread rubber and carcass coating rubber are merely lowered, there is caused such a fear that the durability is deteriorated to 80 as an index value under severe conditions, which can sufficiently be solved by lowering 25% Mod. and dynamic modulus of the belt coating rubber.

Moreover, the feature that the reduction of rolling resistance aimed at the invention is more advantageously promoted by lowering 25% Mod. and dynamic modulus of the belt coating rubber results from analytical results for the deformation state of the belt during the rotation of the tire. Here, the deformation of the belt means a slip deformation produced in the belt composed of not less than two layers (interlaminar shearing deformation), which is particularly important in such a viewpoint that it concentrates in the vicinity of end portions of the belt to increase the internal friction loss. That is, the strain produced by the interlaminar shearing deformation of the belt is determined mainly by various dimensions such as curvature of tire tread portion, curvature of belt, angle of cords arranged in belt, width of belt and

1169344

the like, so that the belt is subjected to a substantially constant strain even when changing the properties of the belt coating rubber. On the basis that the strain of the belt is constant, the internal friction loss of the belt coating rubber is also expressed by the equation (1). For this reason, the internal friction loss of the belt coating rubber can be reduced to improve the rolling resistance by lowering the static modulus C or dynamic modulus G' of the equation (1) without the change of loss tangent, loss modulus or rebound resilience as carried out in the prior art.

Since the improvement of rolling resistance in the high internal pressurized tire is related to members arranged in the tread portion and having a large contribution ratio to internal friction loss as previously mentioned, the change of the modulus in the belt coating rubber is also more advantageous for the reduction of the rolling resistance. Really, a change of the rolling resistance was measured by changing 25% Mod. or dynamic modulus of the belt coating rubber under a high internal pressurized condition (internal pressure=2.5 kg/cm^2) to obtain results as shown in Figs. 4a and 4b. From the data of Figs. 4a and 4b, it has been confirmed that if the index of rolling resistance is 100 in case that 25% Mod. of the belt coating rubber is 15.0 kg/cm^2, the rolling resistance of the tire can be improved to 92-86 as an index value when the belt coating rubber has 25% Mod. of 4.0-10.0 kg/cm^2 and dynamic modulus of 16.2-40.5 kg/cm^2. Moreover, when 25% Mod. is less than 4.0 kg/cm^2 and the dynamic modulus is less than 16.2 kg/cm^2, the belt

containing cords arranged in a unidirection is too soft and the manufacture of tire becomes practically difficult.

In order to confirm the concrete effect of the invention, the following tests were made with respect to a tire having a size of 185/70 SR 14 as shown in Fig. 5, wherein reference numeral 1 is a top-tread rubber, reference numeral 2 an under-tread rubber, reference numeral 3 a belt, reference numeral 4 a carcass, reference numeral 5 a sidewall portion and reference numeral 6 a bead core.

At first, a control tire was prepared by using an under-tread rubber having 25% Mod. of 9 kg/cm^2 and dynamic modulus of 37.4 kg/cm^2, a belt coating rubber having 25% Mod. of 15.0 kg/cm^2 and dynamic modulus of 59.0 kg/cm^2 and a carcass coating rubber having 25% Mod. of 9.3 kg/cm^2 and dynamic modulus of 38.2 kg/cm^2, which was usually used under an internal pressure of 1.7 kg/cm^2. Then, the rolling resistance of the control tire was measured at running speeds of 50, 80 and 100 km/hr under internal pressures of 1.7 kg/cm^2 and 2.5 kg/cm^2 to obtain results as shown in the following Table 3, wherein the improvement of the rolling resistance is expressed by an index on the basis that the control tire used under the internal pressure of 1.7 kg/cm^2 is 100 and the smaller the index value, the better the improvement of the rolling resistance. From the data of Table 3, it is understood that when the control tire is used under a high internal pressurized condition (Internal pressure=2.5 kg/cm^2), the rolling resistance is improved by about 15% as compared with that of the control tire used under the internal pressure of 1.7 kg/cm^2.

Table 3

Index of rolling resistance at a given running speed \ Internal pressure	1.7 kg/cm²	2.5 kg/cm²
50 km/hr	100	85
80 km/hr	100	87
100 km/hr	100	88

Then, there were provided four tires C-F, each being an embodiment of the invention, and then the rolling resistance thereof was measured at running speeds of 50, 80 and 100 km/hr under the internal pressure of 2.5 kg/cm² to obtain results as shown in the following Table 4 together with the result of the control tire. These four tires C-F had the same size, structure and rubber properties as in the control tire except 25% Mod. and dynamic modulus of the rubber shown in Table 4.

1169344

Table 4

	Control tire	Tire C	Tire D	Tire E	Tire F
Internal pressure (kg/cm²)	1.7	2.5	2.5	2.5	2.5
Under-tread rubber					
25% Mod. (kg/cm²)	9	6.5	6.5	6.5	6.5
Dynamic modulus (kg/cm²)	37.4	26.0	26.0	26.0	26.0
Carcass coating rubber					
25% Mod. (kg/cm²)	9.3	9.3	9.3	6.0	6.0
Dynamic modulus (kg/cm²)	38.2	38.2	38.2	20.4	20.4
Belt coating rubber					
25% Mod. (kg/cm²)	15.0	15.0	8.0	15.0	8.0
Dynamic modulus (kg/cm²)	59.0	59.0	32.9	59.0	32.9
Index of rolling resistance at a given running speed					
50 km/hr	100	72	65	62	50
80 km/hr	100	73	66	65	54
100 km/hr	100	75	68	66	53

As apparent from Table 4, the rolling resistance of the high internal pressurized tires according to the invention is considerably improved by selecting 25% Mod. and dynamic modulus of the under-tread rubber as well as those of the carcass coating rubber and/or the belt coating rubber within the particular ranges of lower values as compared with the control tire, so that merits by high internal pressurization of the tire can advantageously be realized. Particularly, the improvement of the rolling resistance is about 26% in the tire C, about 34% in the tire D, about 36% in the tire E and about 48% in the tire F as compared with the control tire.

Next, each of the control tire and tires C-F was placed on a drum provided with a protrusion and then run at a low or high rotating speed, during which a force produced on the rotational axis of the tire was measured for evaluation of ride feeling against vibration to obtain results as shown in the following Table 5, wherein the ride feeling against vibration is expressed by an index on the basis that the control tire (internal pressure=1.7 kg/cm^2) is 100 and the larger the index value, the better the property.

1169344

Table 5

	Running condition	Control tire (Internal pressure =1.7kg/cm²)	Control tire (Internal pressure =2.5kg/cm²)	Tire C (Internal pressure =2.5kg/cm²)	Tire D (Internal pressure =2.5kg/cm²)	Tire E (Internal pressure =2.5kg/cm²)	Tire F (Internal pressure =2.5kg/cm²)
Reaction force in up and down direction when riding on protrusion	low speed area	100	90	102	103	98	101
	high speed area	100	81	99	100	99	98
Reaction force in front and rear direction when riding on protrusion	low speed area	100	89	100	102	98	105
	high speed area	100	95	102	102	100	100

As apparent from the data of Table 5, the ride feeling against vibration of the tires C-F according to the invention is substantially equal to that of the control tire (internal pressure=1.7 kg/cm²), i.e. the deterioration of ride feeling against vibration is not actually caused even under a high internal pressurized condition. On the contrary, when the control tire is used under a higher internal pressure (2.5 kg/cm²), the rolling resistance is somewhat improved, but the ride feeling against vibration is considerably deteriorated as apparent from the comparison of Tables 3 and 5.

Furthermore, each of the control tire and tires C-F was measured with respect to the restoring torque in cornering to obtain results as shown in the following Table 6, wherein the restoring torque is expressed by an index on the basis that the control tire (internal pressure=1.7 kg/cm²) is 100 and the larger the index value, the better the property.

Table 6

Control tire (Internal pressure =1.7kg/cm²)	Control tire (Internal pressure =2.5kg/cm²)	Tire C (Internal pressure =2.5kg/cm²)	Tire D (Internal pressure =2.5kg/cm²)	Tire E (Internal pressure =2.5kg/cm²)	Tire F (Internal pressure =2.5kg/cm²)
100	72	100	101	99	102

As apparent from Table 6, the restoring torque of the control tire is considerably deteriorated when using under a higher internal pressurized condition (internal pressure=2.5 kg/cm²), while the tires according to the

invention do not cause the decrease of the restoring torque.

Moreover, when the tires C-F according to the invention were run on a drum under severe conditions of higher internal pressure (3.0 kg/cm^2) and higher load (200% JIS load), there was caused no great difference in the properties between the tire according to the invention and the control tire.

The following tests were made with respect to a tire G having a size of 175/65 R 13 and an aspect ratio of 0.65 as shown in Fig. 6, which is another embodiment of the high internal pressurized tire according to the invention (internal pressure=2.5 kg/cm^2). In the tire G, the under-tread rubber had 25% Mod. of 6.5 kg/cm^2 and dynamic modulus of 26.0 kg/cm^2, the carcass coating rubber had 25% Mod. of 9.3 kg/cm^2 and dynamic modulus of 38.2 kg/cm^2 and the belt coating rubber had 25% Mod. of 8.0 kg/cm^2 and dynamic modulus of 32.9 kg/cm^2. For the comparison, there was used the same control tire (internal pressure=1.7 kg/cm^2) as described above except that a tire size is 145 SR 13 and an aspect ratio is 0.82. These two tires were measured with respect to the rolling resistance, durability and cornering stability under the following test conditions to obtain results as shown in the following Table 7, wherein each property is expressed by an index on the basis that the control tire is 100.

(1) Test for rolling resistance:

The tire was rotated on a drum having a diameter of 1,707 mm by the driving of a motor, and thereafter the driving of the motor was stopped

to run the drum by inertia, during which the rolling resistance was measured from the degree of deceleration speed. The smaller the index value, the better the property.

(2) Test for durability:

The tire was run on the drum under severe conditions of high internal pressure and high load, during which a running distance till the occurrence of tire failure was measured. The larger the index value, the better the property.

(3) Test for cornering stability:

The cornering power was measured with respect to the tire running on the drum. The larger the index value, the better the property.

Table 7

	Rolling resistance	Durability	Cornering stability
Control tire	100	100	100
Tire G	71	100	103

As mentioned above, according to the invention, the rolling resistance of pneumatic radial tires for passenger cars used under a higher internal pressure of 2.0-3.0 kg/cm^2 can advantageously be reduced without causing the deterioration of ride feeling against vibration and the decrease of restoring torque in the cornering, which are drawbacks in the conventional high internal pressurized tire. Furthermore, the tire according to the

invention is excellent in the cornering stability and durability even when it has an aspect ratio of not more than 0.7.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:-

1. In a pneumatic radial tire for passenger cars used under a high internal pressure of 2.0-3.0 kg/cm^2, comprising a body reinforcement including in combination of a carcass composed of at least one rubberized ply containing organic fiber cords arranged in a substantially radial plane of the tire and wound around a bead core from the inside toward the outside thereof and a belt composed of at least two rubberized layers superimposed about a crown portion of the carcass, each of which containing high elasticity cords inclined at a relatively small angle with respect to the circumferential direction of the tire and the cords of these layers being crossed with each other, and further comprising sidewall rubbers disposed at both sides of the carcass and a tread rubber with a two layer structure composed of an under-tread rubber completely covering the outer surface of the belt and a top-tread rubber superimposed thereabout, the improvement wherein said under-tread rubber has a modulus at 25% elongation of 2.0-8.0 kg/cm^2 and a dynamic modulus of 8.2-33.0 kg/cm^2.

2. The pneumatic radial tire according to claim 1, wherein a coating rubber for said belt has a modulus at 25% elongation of 4.0-10.0 kg/cm^2 and a dynamic modulus of 16.2-40.5 kg/cm^2.

3. The pneumatic radial tire according to claim 1 or 2, wherein a coating rubber for said carcass has a modulus at 25% elongation of 2.0-6.0 kg/cm^2 and a dynamic modulus of 8.2-20.4 kg/cm^2.

1169344

4. The pneumatic radial tire according to claim 1, wherein said under-tread rubber has loss modulus and loss tangent smaller than those of said top-tread rubber.

5. The pneumatic radial tire according to claim 1, wherein said tire has an aspect ratio of not more than 0.7.

1169344
6-1

FIG.1

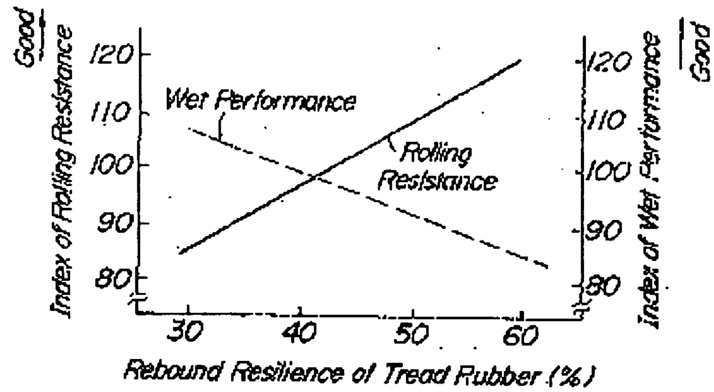
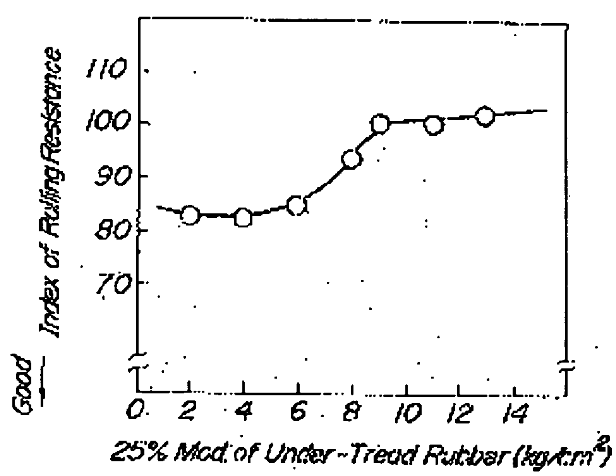


FIG.2a



PATENT AGENTS

1169344
6-2

FIG.2b

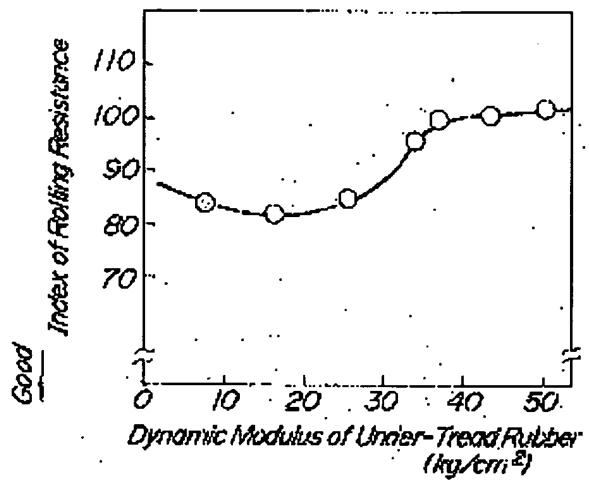
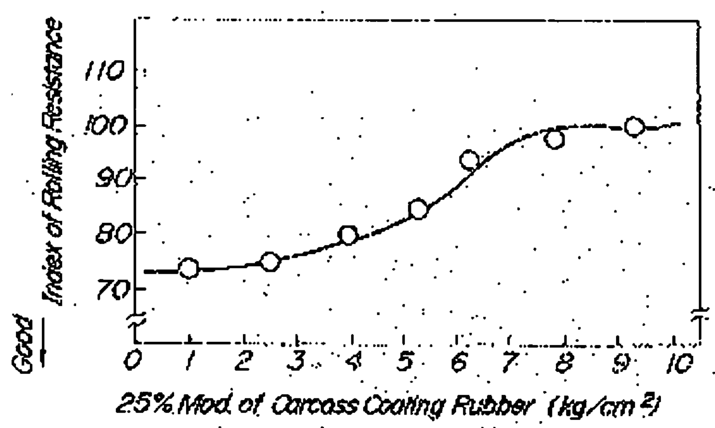


FIG.3a



Gowling, Strathy & Henderson

PATENT AGENTS

1169344
6-3

FIG.3b

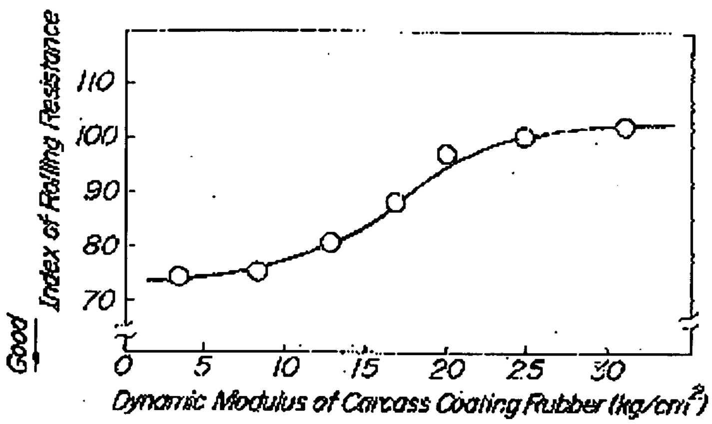
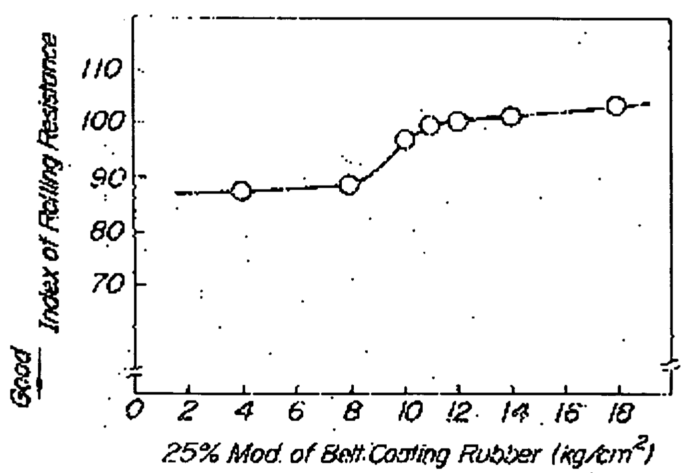


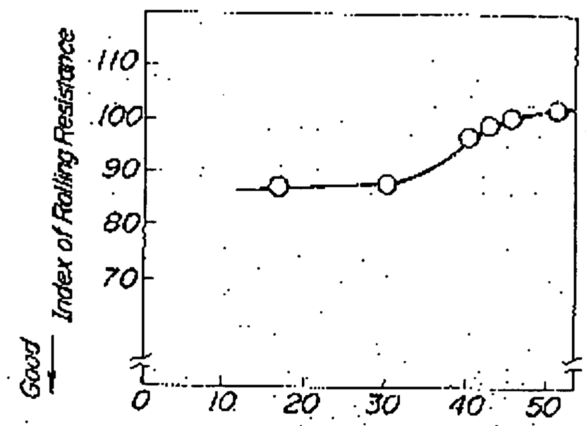
FIG.4a



Smart & Biggar
PATENT AGENTS

1169344
6-4

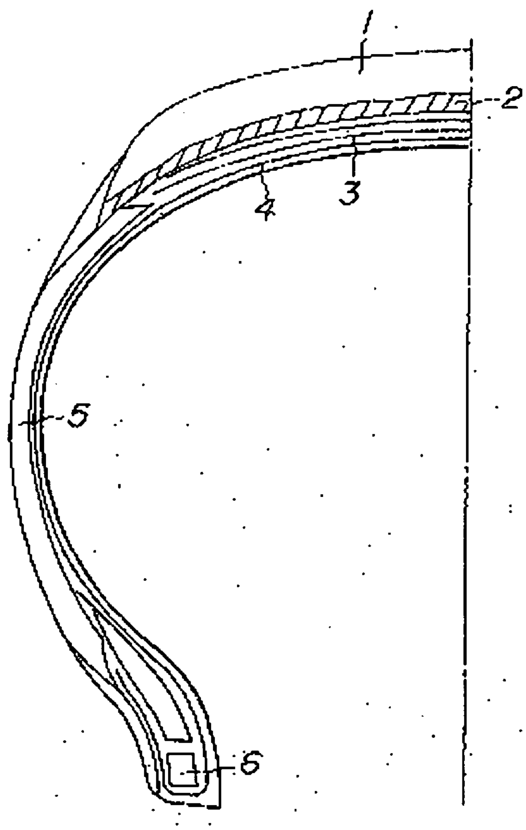
FIG. 4b



PATENT AGENTS

1169344
6-5

FIG. 5

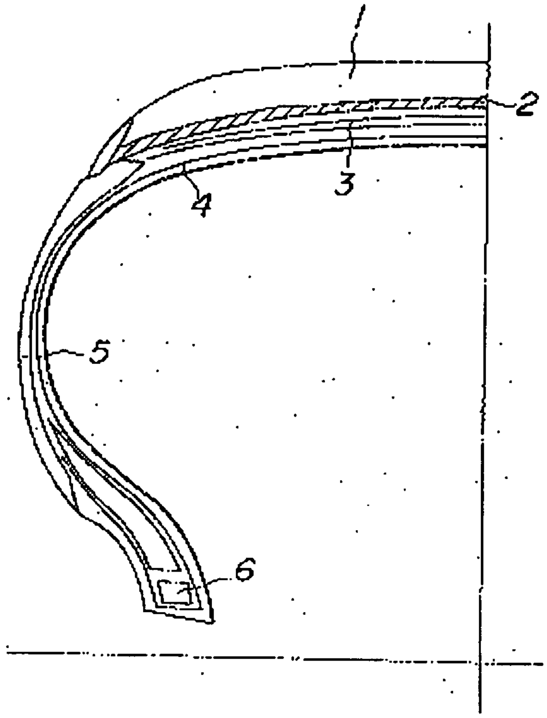


Swabey, Mitchell, Houle, Marcus & Sher

PATENT AGENTS

1169344
6-6

FIG. 6



Smart, Mitchell, Howe, Biscotti & Stead

PATENT AGENTS